

# Head Trauma Acute Care

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# Epidemiology

- 1.4 million people sustain a TBI each year in the United States:
  - 50,000 die
  - 235,000 are hospitalized
  - 1.1 million are treated and released from an emergency department

# Epidemiology

- Americans currently with a long-term or lifelong need for help to perform ADL's as a result of a TBI.
  - At least 5.3 million
  - 2% of the U.S. population
- Direct medical costs and indirect costs such as lost productivity of TBI totaled an estimated \$60 billion in the United States in 2000.

# Definition

- Traumatic Brain Injury (TBI) is caused by a blow or jolt to the head (closed head injury) or a penetrating head injury that disrupts the normal function of the brain.
- Because of the heterogeneous nature of TBI it is better classified as a syndrome rather than single disease.

# Classification By Injury Severity

Initial severity	Initial GCS	Outcome (%) 1 year	Outcome (%) 1 year	Outcome (%) 1 year	Outcome (%) 1 year
		Dead or vegetative	Severe disability	Moderate disability	Good recovery
Mild	13–15	8	20	28	45
Moderate	9–12	16	22	24	38
Severe	3–8	38	29	19	14

# Patho-Anatomic Classification

- “where and what” terminology
- Severe TBI patients usually have more than 1 diagnosis in this classification scheme.
  - Scalp laceration and contusion
  - Skull fracture
  - EDH
  - SDH
  - SAH
  - Brain contusion and laceration
  - Intraparenchymal hemorrhage
  - Intraventricular hemorrhage
  - Focal and diffuse patterns of axonal injury

## Primary Injury Physical Mechanism

- Contact loading
  - Skull fracture
  - Brain contusion
  - Epidural hematoma
- Noncontact loading
  - Concussion
  - DAI
  - SDH
- Blast

## Secondary Injury Pathophysiology

- Hypoxia
- HTN
- Hypercarbia
- Hyponatremia
- Seizure
- Hypo/hyperthermia
- Brain Edema
- Ischemia
  - Microvascular disruption
- Inflammation
- Excitotoxicity

# Traumatic Brain Injury Guidelines METHODS

- **Class I Evidence**
  - derived from randomized controlled trials.
  - However, some may be poorly designed, lack sufficient patient numbers, or suffer from other methodological inadequacies that render them Class II or III.
- **Class II Evidence**
  - derived from clinical studies in which data were collected prospectively, and retrospective analyses that were based on reliable data.
  - Comparison of two or more groups must be clearly distinguished.
  - Types of studies include observational, cohort, prevalence, and case control.
  - Class II evidence may also be derived from flawed RCTs.
- **Class III Evidence**
  - derived from prospectively collected data that is observational, and retrospectively collected data.
  - Types of studies include case series, databases or registries, case reports, and expert opinion.
  - Class III evidence may also be derived from flawed RCTs, cohort, or case-control studies.



# *Traumatic Brain Injury Guidelines*

## Blood Pressure and Oxygenation

- Level I
  - There are insufficient data to support a Level I recommendation for this topic.
- Level II
  - Blood pressure should be monitored and hypotension (systolic blood pressure < 90 mm Hg) avoided.
- Level III
  - Oxygenation should be monitored and hypoxia (PaO<sub>2</sub> < 60 mm Hg or O<sub>2</sub> saturation < 90%) avoided.

# *Traumatic Brain Injury Guidelines*

## Hyperosmolar Therapy

- Level I
  - There are insufficient data to support a Level I recommendation for this topic.
- Level II
  - Mannitol is effective for control of raised intracranial pressure (ICP) at doses of 0.25 g/kg to 1 g/kg body weight.
  - Arterial hypotension (systolic blood pressure < 90 mm Hg) should be avoided
- Level III
  - Restrict mannitol use prior to ICP monitoring to patients with signs of transtentorial herniation or progressive neurological deterioration not attributable to extracranial causes

# *Traumatic Brain Injury Guidelines*

## Intracranial Pressure Monitoring

- Level I
  - There are insufficient data to support a Level I recommendation for this topic.
- Level II
  - Intracranial pressure (ICP) should be monitored in all salvageable patients with a severe traumatic brain injury (TBI; Glasgow Coma Scale [GCS] score of 3-8 after resuscitation) and an abnormal computed tomography (CT) scan.
  - An abnormal CT scan of the head is one that reveals hematomas, contusions, swelling, herniation, or compressed basal cisterns.
- C. Level III
  - ICP monitoring is indicated in patients with severe TBI with a normal CT scan if two or more of the following features are noted at admission: age over 40 years, unilateral or bilateral motor posturing, or systolic blood pressure (BP) < 90 mm Hg

# *Traumatic Brain Injury Guidelines*

## Intracranial Pressure Thresholds

- Level I
  - There are insufficient data to support a Level I recommendation for this topic.
- Level II
  - Treatment should be initiated with intracranial pressure (ICP) thresholds above 20 mm Hg.
- C. Level III
  - A combination of ICP values, and clinical and brain CT findings, should be used to determine the need for treatment

# Methods

- multicenter, controlled trial in which 324 severe TBI patients being treated in intensive care units (ICUs) in Bolivia or Ecuador were randomly assigned to one of two specific protocols:
  - protocol for monitoring intraparenchymal intracranial pressure was used (pressure-monitoring group)
  - protocol in which treatment was based on imaging and clinical examination (imaging–clinical examination group).

# Results

- There was no significant between-group difference in the primary outcome;
  - a composite measure based on percentile performance across 21 measures of functional and cognitive status
  - 56 in the pressure-monitoring group vs. 53 in the imaging–clinical examination group;  $P=0.49$ .
- Six-month mortality was 39% in the pressure-monitoring group and 41% in the imaging–clinical examination group ( $P=0.60$ ).

# Cerebral Perfusion Thresholds

- $CPP = MAP - ICP$
- Level I
  - There are insufficient data to support a Level I recommendation for this topic.
- Level II
  - Aggressive attempts to maintain cerebral perfusion pressure (CPP) above 70 mm Hg with fluids and pressors should be avoided because of the risk of adult respiratory distress syndrome (ARDS).
- Level III
  - CPP of <50 mm Hg should be avoided.
  - The CPP value to target lies within the range of 50-70 mm Hg.

# Nutrition

- Level I
  - There are insufficient data to support a Level I recommendation for this topic.
- Level II
  - Patients should be fed to attain full caloric replacement by day 7 post-injury.



# *Traumatic Brain Injury Guidelines*

## Antiseizure Prophylaxis

- Level I
  - There are insufficient data to support a Level I recommendation for this topic.
- Level II
  - Prophylactic use of phenytoin or valproate is not recommended for preventing late posttraumatic seizures (PTS).
  - Anticonvulsants are indicated to decrease the incidence of early PTS (within 7 days of injury). However, early PTS is not associated with worse outcomes

# *Traumatic Brain Injury Guidelines*

## Hyperventilation

- Level I
  - There are insufficient data to support a Level I recommendation for this topic.
- Level II
  - Prophylactic hyperventilation (PaCO<sub>2</sub> of 25 mm Hg or less) is not recommended.
- Level III
  - Hyperventilation is recommended as a temporizing measure for the reduction of elevated intracranial pressure (ICP).
  - Hyperventilation should be avoided during the first 24 hours after injury when cerebral blood flow (CBF) is often critically reduced.

# Steroids

- Level I
  - The use of steroids is not recommended for improving outcome or reducing intracranial pressure (ICP).
  - In patients with moderate or severe traumatic brain injury (TBI), high-dose methylprednisolone is associated with increased mortality and is contraindicated.

# Guidelines for the Surgical Management of Traumatic Brain Injury

- *Practice Standards*
  - *Class I* evidence is used to support treatment recommendations of the strongest type reflecting a *high degree of clinical certainty*.
  - Evidence from one or more well designed clinical trials
- *Practice Guidelines*
  - *Class II* evidence is used reflecting a *moderate degree of clinical certainty*.
  - Evidence from one or more comparative clinical studies
    - E.g. nonrandomized cohort studies, case control studies
- *Practice Options*
  - *Class III* evidence supports options reflecting *unclear clinical certainty*.
  - Evidence from case series, comparative studies with historical controls case reports, and expert opinion

# Surgical Management of Acute Epidural Hematomas

- **Indications for Surgery**

- An epidural hematoma (EDH) greater than 30 cm<sup>3</sup> should be surgically evacuated regardless of the patient's Glasgow Coma Scale (GCS) score.
  - (ABC)/2
- Nonoperative management with serial computed tomographic (CT) scanning and close neurological observation in a neurosurgical center may be employed if:
  - An EDH less than 30 cm<sup>3</sup> *and*,
  - less than a 15-mm thickness *and*,
  - less than a 5-mm midline shift (MLS) *and*
  - GCS score is greater than 8 *without* focal deficit

- **Timing**

- It is strongly recommended that patients with an acute EDH in coma (GCS score < 9) with anisocoria undergo surgical evacuation as soon as possible.

- **Methods**

- There are insufficient data to support one surgical treatment method. However, craniotomy provides a more complete evacuation of the hematoma.

# Surgical Management of Acute Subdural Hematomas

- **Indications for Surgery**

- An acute subdural hematoma (SDH) with a thickness greater than 10 mm *or* a midline shift greater than 5 mm on computed tomographic (CT) scan should be surgically evacuated, regardless of the patient's Glasgow Coma Scale (GCS) score.
- All patients with acute SDH in coma (GCS score less than 9) should undergo intracranial pressure (ICP) monitoring.
- A comatose patient (GCS score less than 9) with an SDH less than 10-mm thick and a midline shift less than 5mm should undergo surgical evacuation of the lesion if;
  - the GCS score decreased between the time of injury and hospital admission by 2 or more points on the GCS
  - the patient presents with asymmetric or fixed and dilated pupils
  - the ICP exceeds 20 mm Hg.

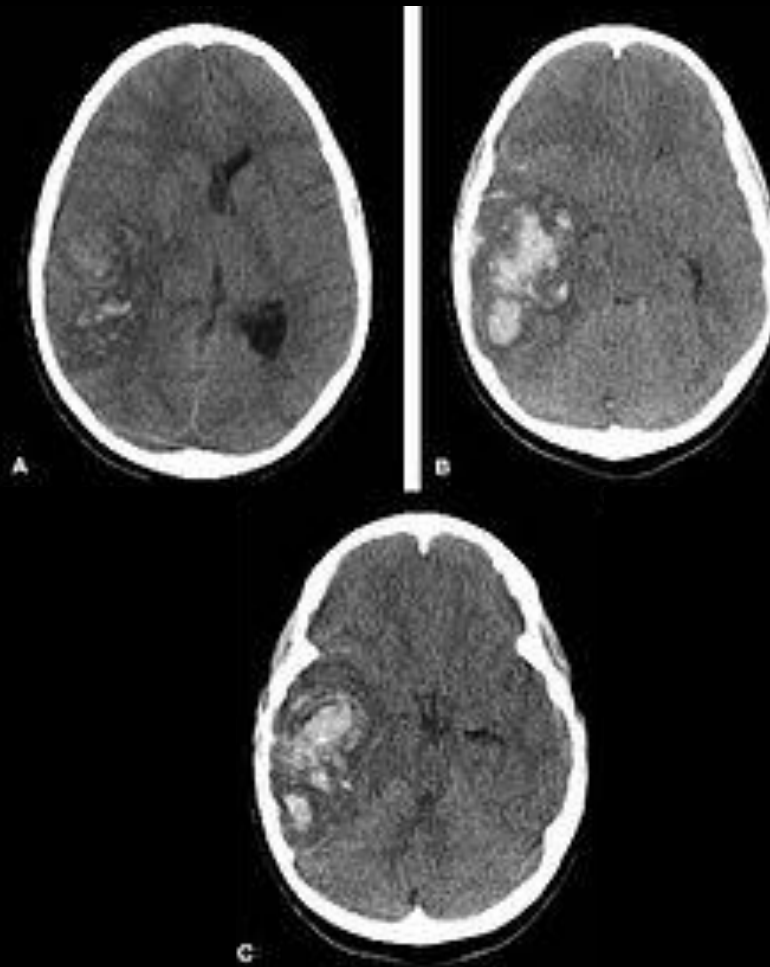
- **Timing**

- In patients with acute SDH and indications for surgery, surgical evacuation should be performed as soon as possible.

- **Methods**

- If surgical evacuation of an acute SDH in a comatose patient (GCS < 9) is indicated, it should be performed using a craniotomy with or without bone flap removal and duraplasty.

# Surgical Management of Traumatic Parenchymal Lesions



# Surgical Management of Traumatic Parenchymal Lesions

- Operative Indications
  - signs of progressive neurological deterioration referable to the lesion
  - medically refractory intracranial hypertension
  - signs of mass effect on computed tomographic (CT) scan
  - Glasgow Coma Scale (GCS) scores of 6 to 8 with frontal or temporal contusions greater than 20 cm<sup>3</sup> in volume with midline shift of at least 5 mm and/or cisternal compression on CT scan
  - patients with any lesion greater than 50 cm<sup>3</sup> in volume should be treated operatively
- Patients with parenchymal mass lesions who do not show evidence for neurological compromise, have controlled intracranial pressure (ICP), and no significant signs of mass effect on CT scan may be managed nonoperatively with intensive monitoring and serial imaging.

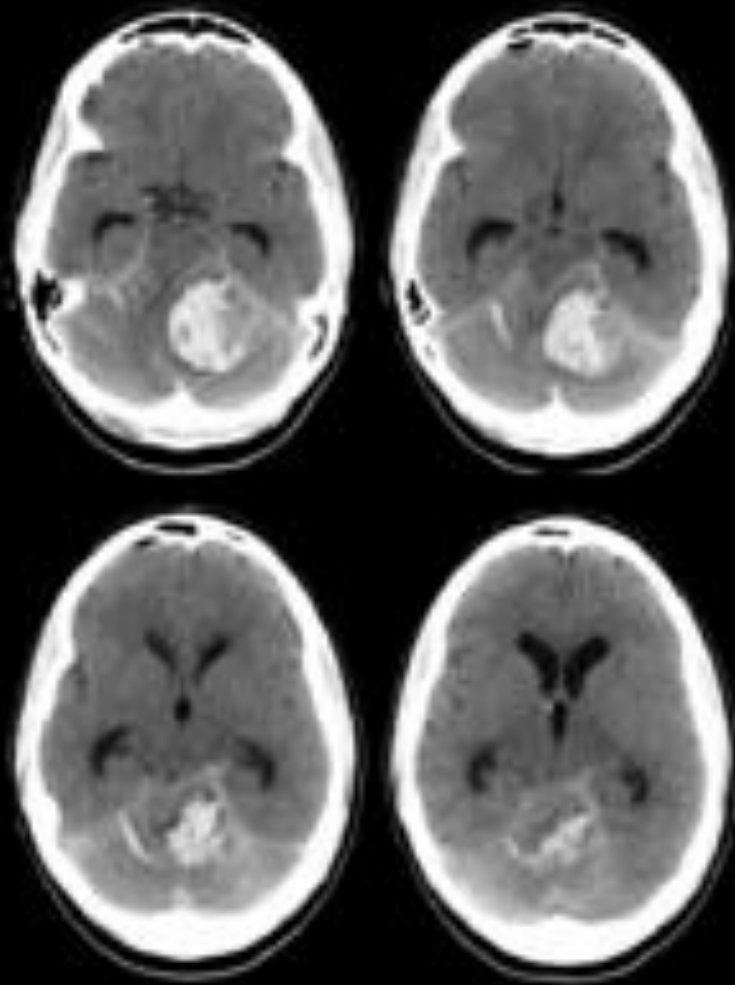


# Surgical Management of Traumatic Parenchymal Lesions

- **Timing and Methods**

- Craniotomy with evacuation of mass lesion is recommended for those patients with focal lesions and the surgical indications listed above.
- Bifrontal decompressive craniectomy within 48 hours of injury is a treatment option for patients with diffuse, medically refractory posttraumatic cerebral edema and resultant intracranial hypertension.
- Decompressive procedures, including subtemporal decompression, temporal lobectomy, and hemispheric decompressive craniectomy, are treatment options for patients with refractory intracranial hypertension and diffuse parenchymal injury with clinical and radiographic evidence for impending transtentorial herniation

# Surgical Management of Posterior Fossa Lesions



# Surgical Management of Posterior Fossa Lesions

- **Indications**

- Patients with mass effect on computed tomographic (CT) scan or with neurological dysfunction or deterioration referable to the lesion should undergo operative intervention.
  - Mass effect on CT scan is defined as distortion, dislocation, or obliteration of the fourth ventricle; compression or loss of visualization of the basal cisterns, or the presence of obstructive hydrocephalus.
- Patients with lesions and no significant mass effect on CT scan and without signs of neurological dysfunction may be managed by close observation and serial imaging.

- **Timing**

- In patients with indications for surgical intervention, evacuation should be performed as soon as possible because these patients can deteriorate rapidly, thus, worsening their prognosis.

- **Methods**

- Suboccipital craniectomy is the predominant method reported for evacuation of posterior fossa mass lesions, and is therefore recommended.

# Surgical Management of Depressed Cranial Fractures

- **Indications**

- Patients with open (compound) cranial fractures depressed greater than the thickness of the cranium should undergo operative intervention to prevent infection.
- Patients with open (compound) depressed cranial fractures may be treated nonoperatively if there is no clinical or radiographic evidence of;
  - dural penetration,
  - significant intracranial hematoma
  - depression greater than 1 cm
  - frontal sinus involvement
  - gross cosmetic deformity
  - wound infection
  - pneumocephalus
  - gross wound contamination

- Nonoperative management of closed (simple) depressed cranial fractures is a treatment option.

# Surgical Management of Depressed Cranial Fractures

- **Timing**

- Early operation is recommended to reduce the incidence of infection.

- **Methods**

- Elevation and debridement is recommended as the surgical method of choice.
- Primary bone fragment replacement is a surgical option in the absence of wound infection at the time of surgery.
- All management strategies for open (compound) depressed fractures should include antibiotics.